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115

OUTLINES

OF THE

GEOLOGY

OF

LEICESTERSHIRE.

BY W. H. COLEMAN, M.A.,

LATE OF ASHBY-DE-LA-ZOUCH.

SHEFFIELD :
WILLIAM WHITE, FULWOOD PARSONAGE.
1862.

18855. e. 6

NOTICE.

THE accompanying sketch of the Geology of Leicestershire has been drawn up at the request of Mr. W. WHITE, of Sheffield, for insertion in his History and Directory of the County. The Author now takes the opportunity of submitting this outline of his views to the numerous kind friends who have aided and encouraged his researches, in hopes that they will favour him with any corrections of his statements that may occur to them. He will also feel particularly obliged to any who will communicate to him any particulars respecting the history of the Coal field which they may possess; as also sections of stratification obtained from quarries, wells, trial sinkings, and borings for coal, &c.; assuring his friends that, when the opportunity shall arrive, he will have much pleasure in making a public acknowledgment of their kindness. And he trusts that the little tract now presented to them will not be unacceptable, as affording a general view, however imperfect, of a district highly interesting in a Geological point of view.

W. H. C.

Burton-on-Trent, June, 1862.

GEOLOGY

OF

LEICESTERSHIRE.

An idea is very commonly entertained, that variety of surface and scenery are essential accompaniments of geological development; and that a district destitute of these must of necessity be uninstructive to the student. It will, however, be seen from the following sketch, that Leicestershire*, though it has little to boast of in romantic beauty, is by no means deficient in geological interest: and that any one desirous of acquiring a practical knowledge of the earth's internal structure, may find within its limits an ample field of study. It is true that some of the more ancient, as well as some of the more modern formations, are entirely absent from this county; but there are enough present to furnish the student with examples of rocks of every description. He may, if his residence be anywhere near the centre of the county, find within his reach both igneous and sedimentary formations;—tertiary, secondary, and primary strata;—Rocks Azoïc, Palæozoïc, Mesozoïc, and Kainozoïc. The following tabular series of geological formations shows the nature and order of the strata of Leicestershire, and what formations are absent from the county, the latter being distinguished by italics.

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* Geology can hardly be restrained within artificial and political boundaries: and we have found it necessary to extend our survey to some portions of several adjoining counties, including the whole of Derbyshire south of the Trent.

1.	Recent	Tertiary or Kainozoïc.	
2.	Post-pleiocene		
3.	Newer Pleiocene		
4.	*Older Pleiocene*		
5.	*Miocene*		
6.	*Upper Eocene*		
7.	*Middle Eocene*		
8.	*Lower Eocene*		
9.*	*Maestricht Beds*	Cretaceous Formation	Secondary or Mesozoïc.
10.	*Upper Chalk*		
11.	*Lower Chalk*		
12.	*Upper Greensand*		
13.	*Gault Clay*		
14.	*Lower Greensand*		
15.	*Wealden*	Jurassic, or Oölitic Formation.	
16.	*Purbeck*		
17.	*Portland*		
18.	*Kimmeridge Clay*		
19.	*Coral Rag*		
20.	*Oxford Clay*		
21.	*Great Oölite*		
22.	Inferior Oölite		
23.	Lias		
24.	Keuper	Trias, or New Red Formatn.	
25.*	*Muschelkalk*		
26.	Bunter		
27.	Permian		Primary, or Palæozoïc.
28.	Coal Measures	Carboniferous	
29.	Carboniferous Limestone		
30.	*Upper Devonian*	Devonian.	
31.	*Lower Devonian*		
32.	*Upper Silurian*	Silurian.	
33.	*Lower Silurian*		
34.	*Upper Cambrian*	Cambrian.	
35.	Lower Cambrian		
36.	Porphyry	Igneous Rocks.	
37.	Greenstone		
38.	Syenite		
39.	Granite		

We shall discuss the formations that occur in Leicestershire in an order the reverse of that in the preceding table; and, beginning with the primary and associated Ingeous Rocks, we shall proceed upwards to the most recent deposits.

I.—CAMBRIAN AND IGNEOUS ROCKS.

The centre of the county of Leicester is occupied by a group of slaty deposits, with associated masses of rock, showing unmistakeably in their structure the action of intense heat. This district, as might be expected from its volcanic nature, has for the most part a poor and hungry soil, and was, therefore, long left in a state of nature; and though, in consequence of an Act of Parliament passed in the year 1808, it has been enclosed and partially cultivated, it still retains its ancient name of Charnwood Forest. The *Slate*

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* This Table is adapted from Sir Charles Lyell. The formations marked with an asterisk are absent from the British Isles.

Rocks of Charnwood are among the oldest in the British Isles—perhaps the oldest of them all. It is all but certain that they exceed in antiquity the Longmynd, the oldest of the English formations; and the slates of Llanberis, the most ancient of the Welsh. In fact, if there are any British rocks older than those of Charnwood, they are probably the Gneissic series about Cape Wrath, in the extreme north of Scotland. The proof of this extreme antiquity is this:—All the rocks above mentioned as comparable with ours, contain fossils, though the oldest have hitherto yielded only low vegetable forms and one or two zoöphytes. The rocks of Charnwood, however, are apparently destitute of all traces of organized beings, the only approach to such being some obscure markings on slate near Swithland. These Mr. Plant takes for a coral of the genus Favosites; but Professor Ramsay, with greater probability, considers them as the cast of the marks left upon mud by a seaweed lying in the wash of the tide. The Charnwood Rocks are of three principal kinds: slates, porphyries, and green stones, the first greatly predominating. These vary in colour from the dull blue, popularly known as slate colour, to a dirty whitish brown. Sometimes they present a greenish grey tint; but no really green slate or chlorite schist occurs among them. In texture they vary from a coarse grauwacke, to fine roofing slate; and in composition they are in general a clay slate, which, in one quarter, passes into a fine grained quartzose slate, and in places is a mere grit or grauwacke, with a slaty cleavage. Traces of the original bedding of the slate rocks may generally be discovered on careful examination. It is indicated by the *stripe*, or coloured lines, which the face of the rock will often exhibit. It is, however, almost impossible to split these rocks in the plane of their original bedding, for the great heat and pressure, combined with other unknown forces, which have acted on the original clay deposit, in converting it into slate, have sealed up the original bedding planes, and impressed upon the rock a cleavage or tendency to split in certain directions, at tolerably regular angles with the meridian and horizon, but altogether independent of the original plane of stratification, and making all sorts of angles with it. The original stratification, or bedding plane of the slates, is found to dip in various directions; but, on the whole, the beds on the western side of the forest dip to the west, and those on the eastern side to the east. A tolerably straight line may be drawn across the forest, dividing the mass of the beds dipping east from those with a general western dip. This line, therefore, is the *Anticlinal axis of the forest.* Its general direction is from N.N.W. to S.S.E., skirting the Blackbrook valley on its eastern side, and passing by Bawdon Lodge down Lingdale to Holgate Lodge, at the N.E. extremity of Bradgate Park. Along this line, the whole mass of the slate rocks has been upheaved by igneous action from below, and the beds tilted from it on both sides towards the E.N.E. and W.S.W. In all probability, a fracture of the strata took place along the anticlinal line, and a fault, with an upthrow on the W., was the result. If so, the rocks on the E. side of the anticlinal are of a more recent date than those on the W., and having never lain at so great a depth, have, on the whole, suffered less from the metamorphic action of the earth's internal heat. It follows that the lowest beds anywhere exposed are probably those which flank the Blackbrook and Lingdale valleys on their western sides. From the high road at Blackbrook turnpike gate, as far as the Reservoir and Upper Blackbrook farm, the slates on the west of the anticlinal are quartzose. This is also the character of a small outlying patch of forest rock, situated between the letters "Ch" and "arn" in the words "Charnwood Forest Canal," on the ordnance map: at least of its western end, for the eastern is porphyritic. Mr. Jukes calls the rock in this quarter *quartz*, and considers it similar to the quartz rock of Hartshill, near Atherstone, but this is an error. Farther to the S.E. this quartzose slate passes into the ordinary clay slate with coarse cleavage, which is characteristic of the whole mass on the western side of the anticlinal, with the exception of the extreme north-western portions. These, having been subjected to a more intense heat, have not merely been baked into slate, but more or less fused and converted into porphyry.

The *Porphyritic district* commences at Gracedieu and extends nearly two-and-a-half miles to the S.E., with an average breadth of three-quarters-of-a-mile. It comprehends the Whitwick and Thringston Rocks, High Cadman, High Sharpley, Ratchet and Great Gun Hills, Kite Hill (the Monastery), Pelder Tor, High Towers, Timberwood Hill, Green Hills, &c. These, in their rugged craggy outlines, present a miniature representation of a mountain chain, especially when viewed from the west through a veil of mist. The general character of the rock in this quarter is such as to convey irresistibly the impression that it is nothing else than the clay slate itself heated to the melting point, and then crystallized by cooling. It rarely appears to have been in a thoroughly fluid condition, so as to flow like lava; the traces of the original bedding are sometimes evident, though the rock has been transformed from a clay slate to a true crystalline porphyry, yet blocks of unmelted slate are found imbedded in melted matter; and again layers of porphyry alternate in some places with unmelted but porcellanized slate. It would seem therefore that a series of beds of clay more or less pure, resembling the binds and pot clays of the coal measures, were first consolidated into slates and then subjected *in situ* to intense heat under pressure. The purer clays were in consequence simply baked and porcellanized; the loams were rendered viscous by the heat, their bedding for the most part destroyed, and, where fissures allowed of their flowing to a small extent, they enveloped in their substance fragments of the less fusible rocks. Under these circumstances the boundary between the porphyries and the unaltered slates must of course be obscure and uncertain. But both at Whitwick and between Pelder Tor and Green Hill, there are evident beds of slate highly baked, yet not porphyritized, over-lying the porphyries and dipping from them to the west. These must form the uppermost beds on the western side of the forest; for at a short distance to the west the Cambrian Formation is bounded by a great fault running from N.N.W. to S.S.E., from Tickenhall to Copt Oak, and bringing in much more recent strata to the westward.

We now pass to the eastern side of the anticlinal axis. The lowest beds of this division also, are those adjoining the anticlinal; the oldest of them are probably not younger than the uppermost beds of the western division. On the N., at Moorley Hill, the slate passes into a grit or grauwacke, which becomes finer southwards. The upper and more eastern beds are also finer. At Whittle Hill the grain is such as to furnish good hones for sharpening knives. About Beacon Hill the slate is slightly chloritic; and further to the S.E. at Swithland, the cleavage is fine enough for it to be split for roofing slate. It is not, however, so fine nor so hard as the Welsh slate, which in consequence has of late years almost superseded its use, and caused a closing of the quarries. At Groby, where the grain is not quite so fine, the slate is sawn into slabs for chimney pieces, tombstones, cisterns, dairy-troughs, and paving flags, for all of which purposes it is well adapted. Irregularly dispersed among the slate rocks of Charnwood, or scattered along its southern borders, are various masses of greenstone, syenite, or syenitic greenstone; for no single one of these names will suffice to describe rocks, which pass gradually into one another at different points of the same mass. The slate rocks which surround them do not usually exhibit any evident tokens of dislocation and alteration by the presence of these igneous rocks. Hence, it is not improbable that most of them were in existence previous to the deposit about their bases of the sediment which has since been converted into slate. The exterior portion of some of these passes into porphyry, but this does not of necessity show that the contact of the melted matter porphyritized the adjacent slates. It may have been that the outer parts of the melted mass cooled more rapidly than the inner, and in consequence the crystallization was less perfect. For it is pretty certain that the slates, porphyries, greenstones, and syenites, do not materially differ in chemical composition, but are merely modifications of the same basis, variously affected by heat and subsequent more or less gradual cooling. All of them are ultimately decomposed into clay when exposed to the action of the weather. In the interior of the forest we find rocks of this description at Birch Wood, Hammercliffe, &c., forming a line with the porphyritic district of Whitwick and Thringston. Another line stretches at intervals from New Cliff and Long Cliff, by Benscliff, towards Bradgate Park. These lines are roughly parallel to the anticlinal, but there are also scattered masses of similar rock at Bawdon Castle, Great Buck Hill, &c. To these must be added the great mass of Bardon Hill on the W. of the forest, which exhibits great variety in its composition. The central part at the summit of the hill is a decided greenstone, while the quarries at its north-west foot exhibit close-grained passing into scoriaceous porphyries, at length at the very base of the hill overlaid by slates. Some porphyritic dykes of later age traversing the mass have been thoroughly decomposed into an unctuous red clay, in which portions of the original rock are scattered in a state of extreme decay. The central part of the Hammercliff Knoll is somewhat syenitic. Rock of a similar character to that of Bardon shows itself through the red marl in two isolated patches on the west of the hill. One of these is immediately above the "o" of the words "Robin Butts F." on the ordnance map; the other lies immediately west of the hovel, marked at ⅛ m. west of the railway on the N. side of the brook which crosses it between the letters "c & h" in the words "Leicester and Burton Branch Railway."

The main masses of *syenite or syenitic greenstone* extend at intervals along the southern edge of the forest. They are found at Staunton Fields, Cliff Hill (with a small isolated patch near it on the S.E.), Markfield Knoll, Groby, and Bradgate. At these places the rock takes the form of dome-shaped hills, of which Markfield Knoll, rising to the height of 750 feet is the most conspicuous, while others only just appear above the surrounding red marl, beneath which some of them (especially those about Groby) are doubtless connected. It is probable that similar rocks extend beneath the red marls, a long way to the S., for rock of this character was reached in a boring 118 feet deep at Baron Park, a little north of the railway, 6¾ m. from Leicester towards Burton. It occurs also in isolated knolls rising above the red marl at Enderby, Croft, Potter's Marston, Stony Stanton and Sapcote. At all these places the rock is of very similar character being a well crystallized syenitic greenstone of a greenish grey or occasionally pinkish hue. It is locally known as granite, from which it differs by the absence of mica. A little to the E. of Charnwood occur rocks of a similar character, but occasionally containing a sufficiency of mica to allow of our calling them granites. These are found at Brazil Wood and Kinchley Hill, and rise into considerable hills at Buddon Wood and Mountsorrel. At the last-named place the granite is extensively quarried, and furnishes good blocks for pavements. It is largely exported to the eastward into the Liassic and Oölitic districts to be broken up for the roads, no good material for that purpose existing in those parts.*

II.—CARBONIFEROUS ROCKS.

1. *The Carboniferous or Mountain Limestone.*

Could the newer deposits, which flank Charnwood on its eastern and western sides, be stripped off, it is probable that Silurian rocks would be found resting on the Cambrian strata, at no great distance from the Forest; and these would probably dip and increase in thickness both ways from the anticlinal axis. These strata, however, never appear at the surface in Leicestershire: towards the W. they first become visible on the eastern borders of the S. Staffordshire Coalfield; while towards the E. they nowhere reach the surface in this country, though there is reason to believe that they have been reached in a deep bore-hole at Harwich. These Silurian rocks are probably (in Leicestershire) nearly conformable to the Cambrians on which they rest; and both had probably been upheaved and denuded to a considerable extent during the period occupied by the deposit of the Devonian or Old Red Sandstone formation. At this epoch the Cambrian and Silurian rocks of the Midland Counties probably stood above the surface of the sea, so that no deposits of Devonian age took place upon them. Towards the conclusion of the Devonian period, a subsidence of this land apparently took place, leaving a coast line passing from the northern edge of Charnwood to the N. of the S. Staffordshire Coalfield, and then S.W. to Devonshire and Cornwall. In the sea to the N. of this line, gradually grew up the enormous coral reefs constituting the great mass of the Carboniferous or Mountain Limestone of Derbyshire and the north of England. In the county just mentioned the limestones and accompanying beds attain a thickness of 5000 feet; but they rapidly diminish in thickness to the southwards, and thin out against the coast line above indicated. How far they extend in Staffordshire is uncertain; but they certainly fail some way to the N. of Dudley, since Silurian rocks are reached below Coal Measures in many parts of the S. Staffordshire Coalfield. In Somersetshire, as with us, the Carboniferous Limestone is thin, and seems on the point of disappearing against a line of ancient coast to the southward. At Gracedieu, near the N.W. corner of Charnwood, the limestone is seen resting on the Cambrian slates and porphyries. It is here thin and of an impure character, being originally somewhat earthy, and having been partially altered since its first deposit from a carbonate of lime to a dolomite or magnesian limestone, containing about equal parts of lime and magnesia. The fossils are few; but what have been found leave no doubt of the carboniferous age of the deposit. At Gracedieu much of its present exposure is artificial, the New Red formation having been stripped off from a large area in the course of ages of quarrying. Northward the red marls conceal the limestone till we come to Osgathorpe, where it is visible by the brook, both N. and S. of the street of the village. About half-a mile N.W. of Osgathorpe the limestone again appears as a low eminence called Barrow Hill, and three quarters of a mile still farther to the N.W. is a much larger exposure of the same rock, forming the abrupt hill, crested with wood, called Breedon Cloud. Here also the limestone is a dolomite, and much disturbed, the beds dipping to the W. at an angle of about 60°. It is here very evident that the formation is bounded on the N.E. by a fault, throwing down the limestone on that side; for the ragged ends of the broken strata are seen sticking up into the air, and a few hundred yards in the rear of the face of the hill, a valley is found scooped out the red marls in the line of fracture to a depth of two-thirds of the height of the hill. This fault probably coincides with, and is, at all events, roughly parallel to the anticlinal axis of Charnwood, which also, as we have seen, has probably a downthrow to the N.E. One mile still farther to the north is another considerable exposure of the Carboniferous Limestone, rising, like the last, as an island out of the surrounding sea of red marl, and forming the conspicuous hill on which Breedon Church is erected. Here, also, the strata stand at high angles, and are evidently cut off abruptly on the N.E. by the same fault which limits Breedon Cloud on the same side, and of which we find traces again at Wilson, and perhaps at King's Newton, where it forms the north-eastern boundary of the Millstone Grit. Along this line of fracture all the five exposures of the Carboniferous Limestone which have been mentioned appear to be arranged. In all of them the rock is dolomitic, and the fossils chiefly in the state of casts. From the character of those of Breedon and Breedon Cloud, it is inferred that the beds there found belong to the middle of the formation. On the west of Breedon the Carboniferous Limestone is concealed by overlying Red Marls and Sandstones, as also in some places by the Millstone Grit; but in the little valley called Dimminsdale, at the N. end of Staunton Harold Park, it again appears at the surface. Here we have the upper beds of the formation, as is proved by the Limestone Shales and Millstone Grit resting upon the limestone. It is here less dolomitic than at Breedon.

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* The reader will do well to provide himself with quarter sheets 63 N.E. and 63 N.W. of the Ordnance Map, geologically coloured. For a more minute geological account of the Cambrian and Igneous Rocks he should consult Jukes's paper in Potter's Charnwood Forest. An elaborate account of their mineralogical constitution may be found in a paper by W. Phillips and S. L. Kent, in the Annals of Philosophy for January, 1824. And the rocks of Croft, Enderby, &c., are described by the Rev. Jas. Yates, in the Geological Transactions, 2nd series vol. 2, p. 261.

In Calke Park the limestone, as might have been expected from its name [*Ad Calcem*, at the lime] again shows itself; and, finally, at Tickenhall a purer blue limestone, abounding with fossils, is extensively worked. These three patches again lie in one line abutting on a great fault, which cuts them off on the south-west. The stratification is here apparently corrugated at right angles to the fault, the interval from ridge to ridge being about a mile. The same conformation has probably helped to produce the five isolated patches previously described. A small quantity of lead ore is extracted from the limestone in Dimminsdale, but it hardly pays for the working. It is probable that the Carboniferous Limestone, thrown down to the N.E. by the Breedon Fault, is continued beneath the New Red formation all along the northern edge of Charnwood. It seems to have been lately reached in two borings near Sheepshed, at a depth of 150 to 170 yards. Covered by the Shales and Millstone Grit, it is probably continued under the northern end of the Ashby-de-la-Zouch Coalfield for a considerable distance to the W.; but in that direction it most probably thins out everywhere towards the S.: so that the Coal Measures south of a line drawn W.S.W. from Gracedieu rest in all probability on Cambrian or Silurian rocks, without the intervention of the Carboniferous Limestone. For the following list of fossils from the limestone we are indebted to Mr. Hull:—

A.—CEPHALOPODA.*

Orthoceras giganteus. B.
Bellerophon opertus. B.
Bellerophon tenuifasciatus. T.

B.—BRACHIOPODA.

Spirifer duplicicosta. B.
——— subconica. B.
——— papilionacea. B.
——— linguifera. T.
——— glabra. T.
——— rotundata. T.
——— expansa. T.
——— rhomboïdea. T.
——— semicircularis. T.
——— bisulcata. T.
——— striata. B.
Cyrtina septosa. B.
Producta scabricula. T.
——— depressa. T.
——— Martini. T.
——— resupinata. T.
——— gigantea. T.
——— antiquata. T.
——— hemisphærica. T.
Terebratula acuminata. T.
Athyris ———? T.

C.—GASTEROPODA.

Trochus ———? B.
Euomphalus Dionysii. B.
——— tabulatus. B.
——— catillus. T.
Euomphalus carinatus. T.
Acroculia spirata. B.
Macrocheilus ———? B.

D.—ZOÖPHYTA.

Cyathophyllum basaltiforme. T.
Syringopora geniculata. T., B.
Calamopora tumida. T.
Retepora ———? T.
Zaphreutis cylindrica. B.

Of the Echinodermata, an Archæocidaris has been found at Tickenhall; and several species of Encrinite both at Tickenhall and Breedon. At Breedon Cloud they are found in profusion.

2.—*The Limestone Shales or Yoredale Rocks.*

The Limestone Shales are a series of alternating beds of clay, sandstone, and mudstone, much resembling the Coal Measures, but of marine origin, and occasionally containing beds of impure limestone. Beds of this age may be seen resting on the limestones on the E. side of the Tickenhall Quarries. At Dimminsdale, they attain a thickness of 50 feet, and are capped by the Millstone Grit. At Breedon Hill, Breedon Cloud, &c., not only the shales but the upper beds of the limestone itself have been stripped off. But on the west side of the Gracedieu Quarries, the shales may be observed setting in over the limestones; and the well at the West Lodge was sunk through 10 or 12 yards of them. These are all the known localities for this formation in Leicestershire. Like the Carboniferous Limestone itself, the Shales are here approaching their southern limit; having thinned away from 2000 feet, their thickness in Derbyshire and Staffordshire, to 50 feet or less, where last seen in this county.

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* Those marked T are from the upper limestones at Tiokenhall; and B, from the middle beds at Breedon.

3.—*The Millstone Grit.*

The Millstone Grit, a coarse sandstone, forming the base of the Coal Measures, may be seen resting on the limestone shales in Staunton Harold Park. Thence it extends northwards, and occupies the surface over about six square miles, chiefly in the parishes of Tickenhall, Melbourne, and Stanton-by-the-Brigg in Derbyshire. In the direction of Breedon it is covered up by the New Red, but appears as an inlier in the hamlet of Wilson, north of Breedon; and again at the base of the hill overlooking the valley of the Trent at Castle Donington. It is also visible in the floor of the road going up from Thringston Mill to the village, at no great distance from the point where the Shales are seen for the last time near Gracedieu. In the Melbourne District the Millstone Grit is at least 200 feet in thickness. At the base it is a conglomerate, of which the pebbles are small, seldom exceeding the size of a walnut, the majority of them being white quartz. It becomes finer upwards, and is then quarried for building stone, troughs, gate-posts, rick-props, &c.: and at the top it becomes a close fine-grained sandstone, of which scythe-stones are made on Melbourne Common. At Stanton-by-the-Brigg a bed occurs of a peculiar texture, resembling pounded granite re-aggregated; and this perhaps is its real origin. This and the uniform coarse rock which occurs at Repton Rocks, are probably not the Millstone Grit proper, but a bed a little higher in the series, and known as the Rough Rock in Lancashire. Like the Carboniferous Limestone and Shales, the Millstone Grit has become much attenuated from its great development on the Derbyshire moors. It there sometimes attains 200 yards in thickness, whilst here it shows only as many feet. Nevertheless it continues some way to the south, if it be true that the quartz rock at Hartshill, near Atherstone, is altered millstone grit.

4.—*The Coal Measures.*

Resting on the Millstone Grit, or perhaps in some places directly on Silurian or Cambrian rocks, the series of beds known as the Coal Measures will probably occur over a great portion of the county at a distance of a few miles from the borders of Charnwood. They are, however, in most places buried to so great a depth beneath more recent formations, that their existence is only a matter of inference. We must therefore confine ourselves to those districts where the Coal Measures are at the surface, or are certainly known to underlie the newer deposits.

It has been already stated at page 81, that the Cambrian Rocks of Charnwood are cut off on the west by a great fault ranging from N.N.W. to S.S.E., from Tickenhall to Copt Oak. Very little Coal Measure occurs to the E. of this line; some of the lowest beds, destitute of workable coal, occur N. of Thringston in the furrows between the ridges, into which it has been mentioned above that the strata are there thrown. Westward however of this line the strata are thrown down to an extent exceeding in some places 700 yards;

and the Coal Measures continue at the surface or at a moderate depth beneath it, for at least nine miles to the W. and S.W. The district thus occupied by them is named from its central town, "The Coal-field of Ashby-de-la-Zouch." We shall for the future refer to the great fault just mentioned, by the name of the *Thringston Fault.* It forms the north-eastern boundary of the Coal-field to its northern angle at Tickenhall. On the N.W. the Coal-field is bounded by the rise of the Millstone Grit from beneath it, in an irregular line from Tickenhall by the N. of Hartshorne to Bretby. On the S.W. side the limits are unknown; but it certainly extends under newer formations, as far as a line drawn from Linton to Stretton-en-le-Field. Indeed it is probable that the Coal Measures nowhere lie at an inaccessible depth (that is at a distance of more than 700 or 800 yards from the surface) at any point between the Ashby and the Cannock Chase and S. Staffordshire Coal-fields. South eastwards also, though interrupted by a projecting spur of the Cambrian Rocks at Bardon Hill, it is continued beneath the New Red as far at least as Bagworth and Nailston, and probably much farther to the S. and E. In fact, it is probable that coal will hereafter be got from nearly the whole of the area included between the Leicester and Burton Railway on the N.E., the Leicester and Nuneaton Railway on the S.E., the Trent Valley Railway on the S.W., and the known Coal-field on the N.W. On the S.E. the Coal-field is doubtless interrupted by the range of greenstone hills above described as running through Enderby, Croft, Potter's Marston, and Stony Stanton, to Sapcote. But on the E. of that line, and of Charnwood, we know no reason why the Coal Measures should not again set in, underlying the Red Marl and Lias, and not become absolutely inaccessible for some distance to the eastward.* The ascertained area of the Leicestershire or Ashby-de-la-Zouch Coal-field is nearly 100 square miles, but that will be more than doubled if our anticipations of its southern extension should be verified. Unfortunately, however, a large portion of this area is occupied by the lower unproductive strata of the formation; and the profitable extent of the Coal-field is restricted to two bands of small width running parallel to the axis of Charnwood, and the great Thringston boundary fault. To these must be added another somewhat similar band running in the same direction to the South of the other two. Thus, exclusive of the western extension, four divisions of the Ashby Coal-field are constituted, each of which will require a separate examination.

A.—The South Eastern Division, or Ibstock and Bagworth Coalfield.

Concerning the form and dimensions of this branch of the Ashby coalfield, we possess very little information. There are as yet only two collieries situated within it, and as it is everywhere covered up by the New Red formation, our knowledge is derived solely from the works at these collieries. The N.E. and S.E. boundaries are entirely unknown, but it may be conjectured that the coal measures in the former direction either abut against the Cambrian rocks of Charnwood, or are cut off and turned up against them at a fault. On the S.E. they probably continue at an increasing depth for some miles, and, after some interruptions from faults and rolls, eventually thin out against the greenstones between Enderby and Sapcote. The projecting spur of Cambrian rocks running westward from Bardon Hill, and a great fault supposed to run westward through Hugglescote, probably separate the basin of Ibstock from that of Coalville. Westwards, the stratification rises 1 in 12, and the coal seams basset under the New Red sand-stone. But after so doing W. of Ibstock, the lower seams are again brought in by a roll in the stratification, and form a small separate trough at Heather, where the coal measures are exposed in the valley of the Sence, and the coal seams rise and basset in all directions beneath the New Red, except towards the south. At Ibstock the coal measures are reached through 130 or 150 feet of the New Red, and their surface is about 320 feet above the sea. At Bagworth the New Red is 320 feet in thickness, and the surface of the coal measures 200 feet above the sea. Thus it appears that the surface of the coal measures on which the new red was deposited, was by no means horizontal. We have given in an appendix the section of the Bagworth Colliery Shaft. The only coal seams worked either at this colliery or at Ibstock are the *Upper Main Coal* of 5ft. (No. 82) and the *Lower Main* (No. 114) of 8ft. in thickness. Several other seams, some of them of considerable thickness, occur, but their quality is so bad that they are not worth raising. In fact, the best seam, the *Lower Main*, is inferior to the best qualities at Snibston and Moira collieries, and cannot compete with them in the market.* When, however, these rivals are exhausted—an event not very remote—this seam will rise in importance, and works will doubtless be opened in this branch of the field, in places far to the S. and E. of the present limits.

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* It has been reported that the Coal Measures were actually reached in a boring at New Found Pool, north of Leicester; but of this, and another trial boring through the Lias at Billesdon, we have never been able to procure the particulars.

No probable comparison can be constituted between the stratification of the Ibstock and Bagworth basin, and that of the rest of the coalfield, the beds are either altogether of a later date, or, if coeval, were never continuous with those of Snibston and of Moira. In the former case, the Moira and Snibston series may be still buried at an unknown depth below that of Ibstock. In the latter, the projecting spur of Bardon Hill, &c., may, with much probability, be pointed out as the separation which broke the continuity of the swamps on which the peat beds, now condensed into coal, were originally formed. But though the sequence of beds at Bagworth is altogether unlike that of Snibston, it exhibits a remarkable similarity to the stratification of the Warwickshire coalfield. Near the top of the Bagworth Shaft are crowded a number of seams—Nos. 17-19, 22, and 25-27—whose collective thickness is 23 feet. This is about the average thickness of the *Thick Coal* of Bedworth, in Warwickshire, which is known to be formed by the union of several seams. The *Upper Main Coal* of Bagworth seems to correspond to the *Seven Foot Coal* of the Warwickshire Coalfield; and the *Lower Main Coal* of the one, to the *Bench Coal* of the other. There seems, therefore, much probability that the Ibstock and Bagworth series of beds is identical with that of Warwickshire, and this greatly adds to the probability of the theory above mentioned: that the coalfield is continued beneath the New Red over most of the intervening country. The Ibstock and Bagworth basin, so far as it is at present worked, is remarkably free from faults; the few that have been met with in the Ibstock Colliery are of the slightest possible character. The working of this branch of the coalfield is comparatively modern, the Ibstock Pit having been sunk in the year 1825, by a farmer named Thirlby, who owned a small property there. He had the luck to reach coal, and for a time worked the seam, No. 72, of the Bagworth Section; but it was not till the colliery passed into the hands of a company that the pit was sunk to its present depth. The Bagworth Colliery was opened somewhat later, and for some years the Upper Main Coal only was worked there.

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* We have lately been informed that the works at Ibstock having been carried on in a new direction, the quality has been found to improve greatly, nearly equalling that of its rivals.

B.—The North Eastern Division, or Coleorton Coalfield.

From the great North Eastern boundary fault, already described as the Thringston Fault, another which we call the *Coleorton Fault*, branches off somewhere about the middle of the South Western edge of Calke Park. Hence it passes through the hamlet of Heath End, and along a green lane called Callins Lane to Lount Wood, near the top of which it crosses the high road from Ashby to Castle Donington; and thence proceeds by Coleorton Hall Farm and Farm Town to a spot marked by the second "e" in the words "Leicester and Burton Railway" on the Ordnance Map; where the fissure, which it forms, occupies 110 yards of the length of the railway, and is filled with eastern drift. The continuation to the S. from this point has not yet been traced; but it probably passes S. of Ravenston to Kelham Brigg, where if the *Hugglescote Fault*, above alluded to, really exists, it probably falls into it. The space thus included between the Thringston, Coleorton, and Hugglescote Faults is the profitable portion of the coalfield on the E. side of Ashby, and forms what we call the Coleorton and Snibston (or Coalville) Coalfield. It is thus, as will be seen, of a triangular form, having two sides of about 10 miles in length, with a base of nearly 5 m. The whole of this area of about 25 square miles is let down between the faults on its E. and W. The amount of this downthrow increases from N. to S., and on the E. side, in the neighbourhood of Whitwick Colliery, it cannot be less than 2000 feet. The amount of downthrow along the S. side is probably as great, but diminishing westward; that of the west side is probably least, but is not yet ascertained. Against the Thringston Fault on the E. the strata are turned up at high angles, and where the downthrow is greatest they are vertical in the neighbourhood of the fault, but soon recover a more horizontal position as we recede from it to the W. The synclinal axis or bottom of the trough is not far from the Thringston Fault, and parallel to it. From the synclinal the beds rise gradually to the W. at about 1 in 12, and the uppermost seams of coal crop out in succession either at daylight or beneath the unconformable overlying New Red. The lower ones are cut off against the Coleorton Fault; and some of the very lowest are not thrown out by it, but extend some distance to the W. One such, perhaps the *Roaster*, was worked some years ago at Alton Grange, and another shows itself in the railway cutting near Breach Hill Farm. It is probable that the strata are either broken off abruptly, or are turned up at right angles against the Hugglescote Fault. Thence they rise gradually at about 1 in 44 towards the N.W., and the coalseams crop out in succession in that direction. A small fault crosses from the Thringston to the Coleorton Fault at Swannington Incline; but no other is known till we arrive nearly at the apex of the triangle, where several small ones range across in a similar manner.

It will be seen from the section of Swannington Pit, given in the Appendix, that there are numerous seams of coal of workable thickness in this branch of the Ashby Coalfield. Of these the first in a descending order is No. 27, *The Stone Smut Rider*, a coal of but poor quality, which nevertheless was worked in old times at its outcrop near Swannington. The next is No. 37, *The Stone Smut*, a thicker seam of still worse quality. Then follows No. 44, *The Swannington Coal*, formerly called the *Nether Coal*, while erroneously supposed to be the lowest seam. This is of good quality; but has been entirely worked out at Swannington, though still scarcely touched at the Whitwick and Snibston Collieries. *The Soft*, or *Three Quarter Coal*, No. 59, and *The Slate Coal Rider*, No. 70, are thin seams; but *The Slate Coal*, No. 75, is 5 feet thick, though not very good. *The Yard*, No. 93; and *The Rattlejack*, No. 107, are but thin; and *The Stinking Coal*, No. 125, is too sulphureous to work. The best coal in this portion of the field is furnished by No. 133, *The Coleorton Main Coal*, which is the only one now worked at Coleorton, Swannington, Whitwick, and Snibston collieries. Below this are *The Smoile Coal*, No. 134,—*The Yard*, or *Upper Lount*, No. 141,—*The Lount Middle*, No. 147,—*The Lount Nether*, No. 152,—and *The Roaster*, No. 159,—all workable coals, though not of first-rate quality. The Stone Smut and Stone Smut Rider crop out, the former at the N. and the latter at the S. end of the tunnel near St. George's Church, Thringston; and the outcrop of the Swannington may be seen in the cutting at the point where the line to the California Pit leaves the main railway. The Soft Coal may be seen in the cutting north of the Newbold Tunnel; the Slate crops out in Worthington Rough; and the Main and Stinking Coals reach the surface together at Smoile Wood, on the E. side of the high road from Ashby to Castle Donington. These two seams are here united into one, though throughout the Swannington and Coalville district they are parted by about 60 feet of stone and bind. The Smoile Coal crops out near the Lount Potteries, and the Lount Coals in succession between Smoile Wood and Staunton Harold, thence running in a curve through Lount Wood, till they are cut off against the Coleorton Fault. The outcrop of the Roaster is not certainly known; it is perhaps cut off against a crossfault a little S. E. of Staunton Hall. We had till lately supposed that the stratification was continued in a regular manner from the Roaster down to the Heath End or Staunton Harold Coal; but recent trial borings, both at Snibston Colliery and at Lount, have thrown doubt upon this theory. From our present information it seems probable that the series of beds from about 50 yards below the Roaster downwards, is unconformable to those above; and that the Heath End seam forms a small trough rising both N.W. and S.E., bassetting somewhere S. of Staunton Hall, under unconformable overlying coal measures. It consists of two parts, of which the upper is an ordinary coal of about 4 feet thick, separated from the lower by a fireclay in places indurated into stone, and varying from 0 to 4 feet in thickness. The lower bed has about 1¼ feet of bad coal at the top of 7 feet of cannel of good quality. As far as our present knowledge extends, this coal would seem to be limited to the small area included between the Thringston and Coleorton Faults, and the limits above defined. The Coleorton coalfield has been worked from time immemorial, and its best seams exhausted wherever they lay near the surface. The collieries long ago gave its distinctive name to the village originally called Overton, or Orton, but now Coleorton. In the reign of Henry VIII., the Main Coal is recorded to have been on fire for some years at its outcrop in Smoile Wood; probably by spontaneous ignition of the pyritous Stinking Coal above it. Since the steam engine has been applied to mining, the works have been carried to far greater depths, and the valuable parts concealed under the New Red sandstone in the south of the basin were first attacked in earnest by George Stephenson, who established the Snibston Colliery, and created the village of Coalville about the year 1831. The collieries in the neighbourhood of Swannington are now in a dangerous state from the accumulation of water in the old workings, which will require a vigorous effort to pump it off.

C.—The Unproductive Lower Coal Measures.

A considerable, but unknown depth of Coal Measures, destitute of valuable seams, underlies the productive strata and rests upon the Millstone Grit. It is probable that these barren measures increase in thickness towards the N. and W. They are brought up to the surface on the western side of the Coleorton Fault, and occupy the whole of the country to the westward, till we reach a somewhat parallel line of dislocation running from Woodville

Church to Willesley Hall. The town of Ashby is itself situated upon them, and just outside it, on the E., a fault runs, like most of the great dislocations, from N.N.W. to S.S.E. From this line the stratification dips eastward to Coleorton, and westward to Moira; hence it coincides with the Anticlinal Axis of the coalfield. We possess evidence to show that the strata under discussion are at least 1000 feet in thickness; and that scarcely any seam of coal contained in them exceeds 2¼ feet. A coal not quite so thick was worked many years ago at Pistern Hill, north of Smisby, another (or possibly the same) at Smisby itself. A similar seam is seen in a brickyard between Smisby and Ashby; and coals of about the same thickness are found in the Railway Cutting near Breach Hill Farm,—in a well at Ashby Union Workhouse, and elsewhere. There seems to be a gradual dip of the stratification of these lower Coal Measures towards the S., and in consequence some higher beds set in in that direction. We have already mentioned (at page 90) that a seam of some thickness was worked about the year 1830 at Alton Grange; but having never been able to obtain any reliable particulars, we are unable to identify it with any seam in the regular series.

D.—The Western Division; or Moira and Swadlincote Coalfield.

It has been already mentioned that barren coal measures extend from the Coleorton Fault to a great line of dislocation running from Woodville to Willesley. This we call the *Boothorpe Fault*, from a hamlet where its effects are visible on the surface. A few of the lowest workable seams extend in places for a short distance to the eastward of this line; but, on the whole, it cuts off the profitable Moira Basin on the W. from the barren lower coal measures of Ashby on its E. The Boothorpe Fault does not appear to be one sharp fracture, but a succession of steps, with high tilting of the stratification spread over a width of 200 or 300 yards. The result is a dislocation of the beds to the amount of about 1100 feet in the neighbourhood of Boothorpe and Woodville. About a mile to the W. of this, and on the whole parallel to it, runs another fault, known as the *Great Moira*, or *Mammatt's Fault*. This is a clear line of nearly vertical fracture, throwing down the strata to the E., or up to the W., to an extent varying up to 120 yards in the neighbourhood of Moira. From this line for about a mile to the W. the beds rise slightly to the W,; till the known and worked portion of the field appears to be bounded by another great fault running like the others from N.N.W. to S.S.E. At Donisthorpe, where this fault was proved some 60 years ago, it received the name of the *Thorntree Fault;* but so little is known of it to the northward that the Government Surveyors have not ventured to lay it down on the Ordnance Map. It probably runs from Oakthorpe, by the W. end of Donisthorpe Church, along the edge of the Red Formation, a little W. of Barrat Pool, to Castle Gresley Station, and thence nearly along the highroad to Stanton and Stapenhill. We must for the present consider this fault as the western boundary of the Moira Coalfield. It is thus included between the two parallel lines of the Thorntree and Boothorpe Faults. From N.W. to S.E., between these limits the strata lie in the form of an inverted arch. Of this the lowest or deepest part is in the neighbourhood of the Reservoir on Ashby Wolds; and hence the stratification rises towards both N.W. and S.E. In the former direction the coal seams crop out in succession, till the lowest of them appear at the surface or basset under the New Red, about a mile from the Trent at Burton. Southwards also they rise till most of the workable beds have cropped out near Oakthorpe and Measham. Here some faults with a southern downthrow occur, and the lower beds continue nearly level under Measham Field as far as the River Mease at Swepston, where the Coal Measures are covered up by the New Red, and their farther extension to the S.E. has yet to be traced. It will be seen from this that the Moira Coalfield resembles in shape a spoon, of which the south-eastern prolongation to Swepston forms the handle. The western side of the bowl is at present unexplored, but it will, probably, be found that the resemblance is completed by the rising of the strata to the W. The bowl of our spoon is, however, in much the condition of pottery over which a cart wheel has passed. It is cracked in all directions, not only by the faults already described, but by numerous cross ones. Of these by far the most important is the *Stone Wall Fault;* which is, apparently, the north-eastern prolongation of the great fracture which at Seckington, Amington, &c., cuts off the Warwickshire Coalfield on the N.W. The Stone Wall Fault leaves Mammatt's Fault at Hough's Barn, E. of Moira Village, and passing under the canal bridge, near the Cockspur Inn, at Bramborough, it runs S.W., nearly along the course of the Willesley Brook, between Oakthorpe and Donisthorpe. Here it causes a downthrow to the N. of from 100 to 120 yards. From Saltersford, south-westwards to Amington, its continuation is lost under the Red Marl.

The section given in the Appendix will furnish an idea of the succession of beds in this branch of the Coalfield. The numbers refer to the corresponding strata in the section of the Hastings and Grey Pit at Moira, given in Mammatt's Facts. The beds above No. 123 of that section appear to be unconformable to those below. They contain, on Gresley Common, the valuable Sagger and other pot clays; also a fair seam of coal called the *Eln coal* (from its thickness), the equivalent of which at Moira is uncertain. There is reason to believe that about 80 yards above the Eln coal there was once a seam of 8 feet in thickness, which has been denuded everywhere except in some few small and isolated spots. As no such seam occurs at Moira, it seems probable that it has there split up and formed several of the thin beds, which are found near the top of the Hastings and Grey Shaft. From No. 123 Mammatt (38 Gresley Common—a coal of 2 ft. 6 in. at Moira, and 3 ft. 2 in. at Gresley,) downwards, there is little difficulty in identifying the stratification at all the pits in the Moira Basin. The first workable seam lies about 90 yards below No. 123 M.: it is No. 222 M., and is known as the

Dicky Gobbler. It is of good quality, and about 3 feet in thickness; but has been very little worked, except near its outcrops. From 40 to 45 yards below this lies the *Jack Dennis*, *Block* or *Watson Coal*, 3ft. 6in. to 4ft. in thickness, and of rather soft quality: it is No. 271 M. About 70 yards lower is the *Little* or *Five Feet Coal*, No. 335 M., varying from 4 to 5 feet in thickness: it is of tolerably good quality, and has been raised to some extent on Gresley Common. Some 16 yards lower is the *Cannel Coal*, of about 2½ feet, No. 354 M.; and then, after an interval of 40 or 50 yards, come the *Rider*, *Over*, and *Nether Coals*, in various states of aggregation at different pits, and together forming the *Moira Main Coal*. Their combined thickness is from 14 to 17 feet, of which the Rider forms about 3ft., and the Over and Nether 6 or 7 feet each. The Over and Nether coals are in contact over nearly the whole of the Moira field; but just as we approach their northern outcrop we find them separate, and rapidly increase their distance to 60 feet. The Over Coal alone is worked in the southern portion of the basin, and furnishes the best coal in the Ashby Coalfield. About the latitude of Gresley Common the Over coal degenerates, and the Nether improves in quality, and both are worked. Farther still to the N. the Nether coal is the best, and the Over coal is neglected. These facts will be found to have an important bearing on the comparison of the Moira and Coleorton Basins. Ten or twelve yards below the Main Coal at Moira occurs the *Toad Coal*, No. 408 M., 3ft. 6in. to 4ft. thick; and from 13 to 16 yards below the Main in the N. of the field, is the *Little Woodfield*, about 4ft. in thickness: these are no doubt identical. Fifteen yards lower is a hard, splinty coal, formerly got near Measham under the name of the *Slate Coal*, No. 440 M.; at Moira it is from 3½ to 4ft. thick. Towards the N. this coal seems to degenerate, and to be replaced by *black batt*, *i.e.*, carbonaceous shale. Fifty or sixty yards below the Main coal is the *Woodfield*, No. 475 M., a valuable seam of about 6 feet thick, having about a foot of cannel at the top. This is worked about Newhall, but is untouched to the southward. Ten yards lower is the *Stockings Coal*, known also as the *Rafferee*, when (as at Woodville) it passes to the E. of the Boothorpe fault: this is about 8 feet thick, but poor in quality. Twenty yards deeper is the *Eureka*, which, on the E. of the Boothorpe fault, is called the *Pot Clay Coal*, and confounded by the miners with the *Eln Coal* of Gresley Common. This is from 3½ to 4½ feet thick, and one of the best household coals in the field, though too soft to bear distant carriage: it is worked about Newhall and Bretby. At an unknown depth (about 100 yards) below this is the *Anglesey Coal*, of 3ft. 9in., worked near Brislincote Hall. Below this a boring has been made for about 125 yards, in which distance no workable seam occurs.

A suggestion was thrown out by Mammatt, and adopted by Jukes, that the main coals of the Moira and the Coleorton Basins were identical. This conjecture we are now able to prove almost beyond doubt, was correct. In the following table we have arranged, in parallel columns, the corresponding coals of the two branches of the field from the highest workable bed of the Coleorton Basin down to the Roaster, below which, as we have mentioned, the stratification appears to be irregular:—

MOIRA.						COLEORTON.					
Name of Seam.	Thickness.					Name of Seam.	Thickness.				
	ft.	in.		ft.	in.		ft.	in.		ft	in.
Dicky Gobbler	3	0	to	4	6	Stone Smut Rider..	3	6	to	3	9
Interval	39	0	..	56	0	Interval	31	6	..	42	6
No. 250 M.	2	2	..	3	0	Stone Smut	3	4	..	6	0
Interval	55	0	..	85	0	Interval	9	0	..	21	9
Jack Dennis	3	4	..	5	0	Swannington......	3	7	..	4	6
Interval	32	0	,,	49	6	Interval	36	6	..	45	0
No. 286 M.	1	8	..	3	6	Soft or 3-Quarter ..	1	1	..	3	0
Interval	42	0	..	72	0	Interval	34	6	..	39	6
No. 314-316 M. ..	0	10	..	1	5	Slate Coal Rider ..	1	0	..	2	5
Interval	44	0	..	104	0	Interval	12	6	..	41	0
Five-foot	4	0	..	5	2	Slate Coal	4	6	..	6	1
Interval	11	6	..	21	0	Interval	18	0	..	76	0
No. 346 M.	0	9	..	2	6	Yard Coal	2	4	..	4	0
Interval	22	0	..	39	0	Interval	28	0	..	50	6
Cannel	2	3	..	3	0	Rattlejack	2	8	..	4	6
Interval	105	0	..	140	0	Interval	35	6	..	112	0
Rider and Over....	7	6	..	8	9	Stinking	4	3	..	6	6
Interval	0	0	..	60	0	Interval	0	0	..	75	0
Nether	6	0	..	9	0	Coleorton Main....	5	0	..	7	6
Interval	30	0	..	34	0	Interval	18	0	..	25	0
Toad	3	0	..	4	0	Smoile	3	5	..	4	0
Interval	27	0	..	63	0	Interval	28	0	..	30	0
Slate	3	8	..	4	0	Lount Upper	2	11	..	3	0
Interval	61	6	..	75	0	Interval	31	0	..	38	0
Woodfield	5	6	..	6	0	Lount Middle	4	0	..	4	7
Interval	21	6	..	75	6	Interval	33	0	..	60	0
Stockings	6	0	..	9	0	Lount Nether	3	6	..	4	0
Interval	40	0	..	75	0	Interval	9	0	..	24	0
Eureka	4	0	..	5	0	Roaster	2	10	..	3	3

E.—Western extension of the Moira Coalfield.

It has been already stated that the known parts of the Moira Basin are bounded on the W. by the great Thorntree fault. It is probable that there is here a great downthrow to the W., after which the stratification again rises to the westward. Some borings at Donisthorpe, made on the W. of the fault, passed through beds of coal apparently above all those of the Moira field, so that the Main coal could hardly be less than 400 yards deep: these beds rise to the south 1 in 12. About half-a mile west of Saltersford, on the road from Measham to Burton, a coal seam of 11 feet, supposed to be the Moira Main, was reached at 124 yards. There is a tradition that coal was reached in a well at Acresford; and this was certainly the case in a well at Linton, where a seam of 7 inches was found below 14½ yards of Permian and two or three of Coal Measure. More recently coal has been met with in a trial boring in the same neighbourhood. Hence there is every reason to believe that a profitable field remains to be worked for some distance to the W. of the present boundary of the coalfield.

The mining operations about Measham extend back into remote antiquity, as is shown by the circumstance that stone hammer-heads and other rude tools have been found in shallow workings there. There were also "*delphs*" i. e. diggings, on the Wolds several centuries ago, but these were all shallow, and on the outcrops of the upper seams. At Newhall, Swadlincote, &c., there were also ancient workings at the outcrops of the lower beds. About the end of the last century the Main coal about Measham and Oakthorpe was nearly exhausted to a depth of about 60 yards. In 1799, Messrs. Wilkes and Mammatt took the bold step of crossing the great Stone Wall Fault. They succeeded in reaching the Main coal at 150 yards,* and worked it to a considerable distance N. and N.E. In 1804, the Double Pits at Moira were commenced; and a few years later the Furnace Pit. The Bath Pit† followed in 1813; the Hastings and Grey, and the Rawdon, about 1830; and lastly the Canal Head Pit, about 1850. Meanwhile various other Collieries had been opened in the northern part of the field, and the main coal is being everywhere rapidly worked out. Still many seams are nearly untouched; and Mr. Hull is probably under the mark when he calculates that there are in the whole of the Leicestershire Coalfield 150,000,000 tons yet available; which at the rate of consumption now prevailing would last for 200 years.‡

III.—The Permian Formation.

The coal measures of the Leicestershire Coalfield had been already much broken and denuded when the Permian, the formation next in order, was deposited upon them. As the former is a fresh-water, or at least an estuary formation, and the latter a marine, a subsidence of the land must have taken place in the interval. The Permian formation has, however, been itself so extensively denuded at a later period, that it is impossible to say to what extent this subsidence may have taken place. There is, however, great probability that it extended over the whole of the coalfield; though whether Charnwood (in those days doubtless far more lofty than at present) was wholly submerged beneath the waters of the Permian ocean, may reasonably be doubted. That the Permian formation once extended over most of the coalfield is inferred from the occurrence of patches of it left in various localities. Beds of this age occur at Packington, S. of Ashby, and probably at the base of the New Red on the immediate W. of that town. They again occur at Measham Field, where they occupy a considerable area; also under the town of Measham itself; and again at Oakthorpe, W. of it. Farther to the W., near Saltersford, and about ½ m. N. of Stretton, 100 yards of Permian Strata were traversed in a boring for coal. Beds of this age skirt the western edge of the Moira Coalfield, and are brought up at the intersection of two faults at Linton, a mile W. of that boundary. At Round Wolds, N. of Woodville, a small patch of them may be seen; and they are more extensively developed N. of Hartshorne, about Glover's Mill, and thence down the valley towards Repton. But the most important mass of them is that forming Knowl Hill, N. of Tickenhall, and extending as far as the Trent at Ingleby. The Permian rests in different places on very various members of the coal formation, thus showing that extensive denudation had taken place previous to its deposit. At Moira itself, some beds which may belong to the base of the Permian* rest on strata nearly 1000 feet above the Main coal; while at Measham Field and Saltersford, they rest upon the Main coal, or on beds only a few yards above it. At Packington, and probably at Knowl Hill, the Permian rests upon strata far below the Main coal. Hence there is evidence that at least 1000 feet of coal measures had been stripped off from portions of the Ashby Coalfield before the deposit of the Permian. It is stated above, that the Permian attains a thickness of 100 yards near Saltersford. There can be little doubt that this thickness of the deposit was not confined to that spot, but that while so much of it has been there preserved by the accident of its being let down in the angle between the Thorntree and the Stone Wall Faults, it originally covered and was afterwards denuded from a large portion of the neighbouring country. If the present surface of the Coalfield were covered at Moira with a thickness of 100 yards of Permian, that formation would not entirely thin out till it reached the borders of Charnwood. The fragments left at Ashby, Packington, &c., are strong evidence that this was really the original extent of the Permian Formation. The Permian Beds in this county consist of a series of brown sandstones, with partings of marl; the Magnesian Limestone, characteristic of the formation from Nottingham northwards, being here wanting. Occasionally the sandstones became a breccia, composed of fragments of Silurian and Carboniferous Rocks.

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* The section of the Brook Pit, Donisthorpe Old Colliery is given in Mammatt's Geological Facts; as are also those of the Rawdon and the Hastings and Grey Pits. That of the Furnace Pit may be found in Bakewell's Geology, 1838.

† So called from the salt water baths established there. It is not certainly known in what strata this water takes its rise; originally it flowed at the surface in the "*Salt Spring Close*" at Donisthorpe; but the works of the Double Pits having been carried nearly under it, the spring was drained, and the water is now pumped up from a depth of 230 yards at the Bath Pit. A portion of it is conveyed to Ashby-de-la-Zouch for the supply of the Baths there. It is salter than sea water, and contains more bromine, and is in high repute as a remedy for rheumatic affections.

‡ The reader should compare the above account of the Ashby Coalfield with Quarter Sheets 63 N.W. and 71 S.W. of the Ordnance Map. He will find much valuable information in Mr. Hull's paper upon it, comprised in the "Memoirs of the Geological Survey of Great Britain"; as also in a shorter article in "The Coalfields of Great Britain", by the same author. Numerous sections and engravings of fossils are contained in Mammatt's "Geological Facts."

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* They are more probably of the latest part of the coal measure period; unconformable to the lower beds. They are chiefly coarse grits, characterized by the presence of silicified stems of Sternbergia.

This at times is cemented into a hard rock by the lime derived from a portion of the pebbles; at others it is a loose gravel, locally known as Poxon Gravel.* There are also pebbles of basalt and other Trappean rocks, all of which appear to have travelled from the W., for no fragments referable to the Charnwood rocks are to be found among them. Prof. Ramsay judges from their angularity that their transport is due to ice. The Permian Rocks probably increase in thickness towards the S. and W., inasmuch as they are largely developed on the eastern borders of the S. Staffordshire Coalfield; and the Warwickshire Coalfield is cut off against them on the N. A boring of 200 yards in depth at Linley Hall, near Higham, appears to have been partly through this formation, which was not there penetrated. It may very probably increase from 100 yards (its greatest known thickness on the borders of the Ashby-de-la-Zouch Coalfield,) to 800 yards or more, as we recede to the W. and S. If this should prove to be the case, the Permian Formation will oppose a formidable obstacle to the search for coal in those directions.

IV.—The Trias, or New Red Formation.

The Permian Period was succeeded in this country by a time of great disturbance, and almost entire destruction of the existing races of plants and animals; hence it is reputed the last of the Palæozoïc Formations. Extensive dislocations and denudations having taken place, the remains of the older strata seem to have been planed down to a tolerably uniform level throughout the central districts of England. Apparently about this time happened the latest outburst of the volcanic activity of Charnwood. A flood of melted matter, issuing probably from the fissure created by the great Thringston Fault, proceeded from somewhere near the northern foot of Bardon Hill, and spread itself over the Coal Measures, at that time probably forming the bottom of a deep sea. On cooling, this became a compact greenstone, not unlike that forming the core of Bardon Hill itself. One of the shafts at Whitwick Colliery passed through 20 yards of this rock; and at Snibston Colliery 21 ft. 9. in. of it were traversed at the pit nearest the Coalville Railway Station: thus it evidently thins rapidly to the westward, and, as might be expected, was not found in pits farther to the W.

1.—*The Bunter, or Lower New Red Sandstone.*

The ultimate result of the great disturbances above-mentioned was that Charnwood, with the country for seven or eight miles to the N. and W., and for an unknown distance to the S. and E., formed an island, or at least a shoal in the surrounding sea. The Peak of Derbyshire seems to have been similarly circumstanced, and in the sea between the two lands, and for a long way to the W., extensive accumulations of sand and shingle banks took place, forming, when consolidated, the Bunter Sandstone. There is in Leicestershire little or none of the Mottled Sand of this epoch, which is found in force W. of Nottingham; but extensive banks of shingle, now forming the Conglomerate or Pebble Beds, the middle member of the Bunter series, were deposited round the edge of what we may call Charnwood Island. A fine section of this deposit may be seen just outside the boundary of the county at a spot marked "Gravel Pit" on the Ordnance Map, at Waverton, or Warton, near Polesworth, in Warwickshire. Here alternate beds, each about four feet in thickness, of shingle pebbles and drab-coloured sand, rise in a quarry face to the height of 40 feet. From this point the Pebble Beds are probably continued to the north under the Red Marl, and reappear at Nether and Over Seale, Castle Gresley, Stanton, &c., along the western edge of the Moira Coalfield. Along its northern edge, by Bretby, Repton, Hartshorne, Formark, &c., they occur in force, and are probably continued under the Red Marls north-eastwards to Nottingham. The New Red Conglomerates, or Pebble Beds, are very irregular, as might be expected in shingle banks; at times they attain 200 feet in thickness. The lower beds are often reddish, and with but few pebbles; the upper are usually a mass of pebbles imbedded in a drab-coloured sand. At times the pebbles are cemented by lime into a rock so hard that they will rather break than part from the matrix. At others, and especially near the surface, these beds are with difficulty distinguished from recent gravels: in such cases the absence of chalkflints is a useful criterion, though not always conclusive. The majority of the pebbles are a liver-coloured quartz, much resembling the altered Caradoc Sandstone of the Lickey Hills, near Bromsgrove, and still more the altered Millstone Grit of Hartshill, near Atherstone. Pebbles of white quartz, trappean rocks, and Coal Measure Sandstones are interspersed; but Limestone Pebbles are rare, both in this and the Permian breccia above described; they seem to have been dissolved by the infiltration of water, and their material dispersed as cement through the mass.

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* This breccia, though nearly as old as the Coal Measures, was actually called by Mammatt "gravel diluvial."

2.—*The Keuper, or Upper New Red Sandstone, and Gypseous Marls.*

Some time after the conclusion of the Bunter period, (the Upper Variegated Sandstone of Cheshire, as well as the Muschelkalk of Germany, having been deposited in the interval,) the whole of our island seems through a long period of time to have slowly subsided, till little but its highest mountains remained above the waters. During this process a deposit of fine mud and sand was everywhere going on: the sand was dropped chiefly on the beaches of the lands still above water, and a fine red mud in the deeper waters. Hence the base of the Keuper series exhibits everywhere a preponderance of white sandstones, tolerably well adapted for building purposes. These are known as the White, or Passage Beds; and also as the *Water Stones*, because well-sinkers make sure of water when they reach them through the waterless marls above them. These sandstones give evidence of their littoral origin in their ripple-marks, sun-cracks, and rain-marks. The ripple-marked sandstones sometimes (as at Burton Bridge and at Weston-on-Trent,) exhibit tracks of Labyrinthodon. The White Beds occupy from 50 to 100 feet at the base of the formation; after which, the red marl, which had hitherto occurred only as thin partings between the beds of stone, becomes predominant, and forms thick beds. These are separated at intervals by thin tables of gypsum and of a hard flaggy stone, characterised by a small crustacean (*Estheria minuta*), and casts of cubical crystals of salt. These flags sometimes become of importance by protecting the marl below them from denudation. Thus, at Orton-on-the-Hill, a bed of this nature not more than a yard in thickness, has produced a considerable eminence, continued from that village by Norton and Twycross to Gopsall Park. Rarely, as in the railway cutting at Branston, near Leicester, and about the Dane Hills, a bed of soft sandstone is found, remarkable for its false bedding. Besides the thin tables of acicular or fibrous gypsum above mentioned, amorphous gypsum, or alabaster, is found in large nodules in the upper part of the formation. The principal supply of this, probably lies everywhere in one and the same floor; perhaps about 150 or 200 feet from the top of the formation. It may be seen in the railway cuttings at Syston, and at Red Hill; but the best blocks for statuary purposes are got at Chellaston, and at Fauld, near Tutbury. The Keuper series in this county must, where complete, be nearly 1000 feet in thickness; though, by denudation and the original inequality of the sea-bottom on which it was deposited, it is locally much thinner. It runs up into the valleys of Charnwood; and there is reason to believe that the Cambrian rocks of that district were once completely covered up by the Red Marls, if not by later formations also. In Leicestershire, the Keuper is unconformable to everything below it; and rests indifferently on the Cambrians of Charnwood—the Carboniferous Limestones of Gracedieu, Breedon, &c.—the Coal Measures of Coalville, Ibstock, &c.—the Permians of Measham—and the Pebble Beds of Seale, &c. It is remarkably barren of fossils, though a few interesting ones have been found by Mr. Plant in the red and green marls of the higher part of the formation, near Leicester.

V.—The Jurassic or Oölitic Formation.

1. *The Lias.*

The upper beds of the Red Marl appear to have been deposited in water of some depth; but those of the Lias, which next succeed them, were still more certainly a deep water formation. The Trias, as has been observed, is remarkably deficient in organic remains; the Lias on the contrary abounds with them; and it is probably owing in part to this circumstance that the colour and chemical condition of the two series is so strikingly different. In Leicestershire, the Lias rests everywhere upon the Red Marls, to which it is nearly, though probably not quite conformable. Its total thickness is about 300 yards, and it is divided into the Upper and Lower Lias by a calcareous sandstone, called the *Marlstone.* These three divisions occupy nearly one-half of the county on its eastern side, as the bulk of the western half is occupied by the Red Marls. We shall begin our account of the Lias by describing the line of demarcation between these two wide-spread formations.

Descending from the neighbourhood of Newark, in a tolerably straight line from N. to S., the boundary runs through Hawborough, about 1½ m. W. of the extreme northern limits of Leicestershire. It is thence continued by Orston, Elton, Granby and Barnston, to Langar, preserving an average distance of 1½ m. from the boundary of the county. West of Langar, the Lias boundary stretches westward by Cropwell Bishop, south of Cotgrave to Clipston; and leaving a small outlier at Hoe Hill, near Plumtree, it turns S. to Kegworth, where it sends out a promontory to Rancliffe Wood; and then skirting round a mile or so E. of Bunny, it passes to the S. of it along the ridge of Bunny Old Wood, running out three or four miles to the W. and leaving outliers at Gotham Hill, and N. of West Leake. From Hotchley and Sharpley Hills, N. of East Leake, the boundary fetches a compass by Cortlingstock to E. Leake itself, and thence to Rempston, sending out a promontory to Normanton Hills. Returning E. from this point the line enters Leicestershire, near Hoton; having been hitherto three or four miles to the north of the county boundary ever since leaving Langar. The western prolongation of the Lias between Bunny and Hoton is due to a large fault, with a downthrow to the N., which beginning at Castle Donington may be traced at intervals by Hoton, Wartnaby, and Ab Kettleby, to Buckminster, on the eastern edge of the county, a distance of 30 miles. And it is not improbable that another fault, branching from this near Scalford, north of Melton Mowbray, and running by Upper and Nether Broughton, to Bunny, and thence towards Long Eaton, forms the northern limit of the downthrow. From Hoton the line of junction of the Lias and Red Marls passes by the north of Prestwould to Burton, and Preston-on-the-Wolds, whence it runs W. nearly to the Soar and along that river to Barrow-on-Soar. Hence it passes S.E. to Sileby, and E. to Ratcliffe-on-the-Wreke, running up the valley of that river to Hoby, where it crosses the stream and passes S.W. to Brooksby, Queniborough, Barkby, Humberston, and Knighton, near Leicester, whence by Union Mills and Countesthorpe Station, it passes to Dunton Bassett and Ashby Parva, and thence S.W. into Warwickshire. In this latter part of its course from Barrow southwards, the precise line of demarcation is rendered very obscure by deep beds of drift overlying the junction of the top formations. The three divisions of the Lias will now require separate notice.

A.—The Lias Limestone and Lower Lias Clays.

Near the base of the Lias there generally lie several thin beds of a bluish limestone, well known for its valuable property of setting under water. The principal quarries of this stone in this county are at Barrow-on-Soar, after which place the lime is generally named, Here it occurs in seven beds, averaging eight inches in thickness, and interstratified with dark coloured shaly clays, containing bones of saurians and fish, with numerous shells, the whole mass being strongly impregnated with iron pyrites and phosphate of lime. Above the limestones lies an enormous thickness of clay similar to that just described. It is divided at distant intervals by thin beds of mudstone (as near Saddington tunnel) or rarely limestone (as in the brook at Bottesford,) and in one instance (below Belvoir Castle) of soft impure sandstone abounding with ammonites. These clays probably attain, where perfect, a thickness of 500 to 600 feet. Ammonites and belemnites are frequent in them; but the most characteristic fossil is a thick shelled oyster called *Gryphæa incurva.*

B.—The Marlstone.

The clays of the Lower Lias are surmounted by a band of calcareous sandstone called the Marlstone. This, in the neighbourhood of Belvoir Castle, where it caps the hills to the W., is about 20 feet in thickness. It is here highly impregnated with iron, and often, almost wholly composed of shells, among which *Rhynconella (Terebratula) Tetrahedra* is predominant. The soil, where the Marlstone is at the surface, is here called " red land, " though really of a snuff brown. Farther to the S., as at Wymondham, and at Burrough-on-the-Hill, there is little iron, but the fossils are still frequent. But from Billesdon, southwards to the extreme edge of the county at Medbourne, both iron and fossils are in small quantity; and in consequence the Marlstone degenerates to a soft friable rock, no longer producing a feature in the landscape by resistance to denudation, as it had done in the N. of the county. The Marlstone occupies a strip of country of small breadth, running somewhat parallel to the outer boundary of the Lias, and from 8 to 10 miles to the E. of it. It makes a light soil well adapted to the cultivation of barley and turnips, and is usually under plough, while both Upper and Lower Lias are in pasture. The course of this formation is in places broken by faults, or obscured by drift, so that it is not always easy to trace. Beginning at Great Gonerby, north-west of Grantham, we may trace its outer edge by Barrowby, Harlaxton and Denton to Woolsthorpe, where it enters Leicestershire at Belvoir Farm and skirts by Harston and the S. side of Knipton to Branston. Hence it returns N.E. round the Reservoir, and crowns the whole of the high ground W. of Belvoir Castle. The castle itself stands on Lias; but Blackberry Hill, immediately W. of it, is an outlier of Marlstone. From this, the boundary follows the brow of the hills overhanging the vale of Belvoir by Stathern Mill to about 1½m. E. of Long Claxton, where it circles round to Wykeham, between Cauldwell and Scalford, and there appears to be cut off by a fault. At Holwell the Marlstone re-appears, having been thrown down to the W. by this or some other fault, and forms an outlier, the northern boundary of which crests the ridge N. of Ab-Kettleby and Wartnaby as far W. as Green Hill, about a mile from old Dalby-on-the-Wolds. On its southern side this outlier is cut off by the Hoton Fault above described. A small patch of Marlstone is seen as an inlier on the W. of Sproxton; this also seems to be cut off on the S. by the Hoton Fault, which throws back the Marlstone some way to the E.; but the country is here so covered with drift that, with the exception of a doubtful patch just S. of Sewstern, nothing is seen of it till we approach Wymondham, where it appears to set in suddenly at a fault running in the line of the Wreke Valley with a downthrow to the S. From Wymondham the outer edge of the Marlstone runs W. of Edmondthorpe and Teigh; between which places it may be well seen and studied in the cutting of the Oakham Canal. Hence it circles round N. of Ashwell to Whissendine, and to Pickwell and Burrough-on-the-Hill, with an irregular boundary. At Burrough it caps bold hills, one of which is crested by a British camp. Passing W. of Somerby it is barely traceable through Owston, but reappears W. of Owston Lodge Farm, running out westward on the N. of Tilton-on-the-Hill to Billesdon Coplow. Returning S.E. through Billesdon village, it passes in an obscure form through Skeffington and Tugby, Goadby, Glooston and Cranhoe, to Slawston and Medbourne; S.E. of which, near Drayton, it crosses the Welland into Northamptonshire, and returns W. up the southern side of the valley of that river beyond the meridian of Market Harborough. An outlier occurs on the Leicestershire side, S.E. of Stanton Wyville; and another extends from a little N. of Gumley to the Grand Junction Canal about a mile S. of Laughton. The Marlstone appears as an inlier in the valley at Lodington, and again near East Norton and Allexton, and possibly in other places; as outside the boundaries of the county it does at Branston and Brook, south of Oakham. This last town itself stands upon Marlstone, continuous by Barleythorpe and Langham to Ashwell. The inner or eastern boundary of the Marlstone is very obscure, being in most places concealed by drift. For the most part it follows the outer edge at a distance varying from ¼ to 1 mile; after which, it is everywhere covered up to the E. by the clays of the Upper Lias.

C.—The Upper Lias Clays.

On the S. the Upper Lias occupies the whole of the county E. of the line just described as that of the Marlstone. It is here about 100 yards in thickness, and similar in character to the Lower Lias. Northwards it appears to diminish in thickness, and at Sproxton can hardly attain 100 feet. Still farther to the N., it skirts the flanks of the hills between Croxton and Branston, and thence S. of Knipton, Harston, Denton, and Harlaxton to Grantham. Here its thickness seems not to exceed 50 or 60 feet. Lying, however, very flat in a line from E. to W., it covers a considerable extent of country N. of the Hoton Fault, and extends (except where covered by outliers of the Inferior Oölite, or denuded, down to the Marlstone) from the line joining Sproxton, Saltby, and Croxton Kyrial to the outcrop of the Marlstone at Caldwell, Goadby Marwood, and Eastwell.

The *Lias Districts* of the east of Leicestershire form, for the most part, an extremely dull and uninteresting country. Except where the Marlstone diversifies the scenery, and creates bold hills with light arable soil, we find everywhere a lumpish outline, and interminable ox-pastures on an ill-drained retentive soil.* The country is nearly destitute of natural wood, and the roads, from the scarcity of material and the dampness of the subsoil, excessively bad; the water, except that from the Marlstone, impregnated with pyrites. Yet, probably from the abundance of animal matter, and especially phosphate of lime, in the Lias clays, these ugly rushy pastures fatten large herds of oxen, and are the laboratory of the so-called Stilton cheese, of which Melton Mowbray and Leicester are the emporia. They form also one of the most favourite hunting countries in England.

2.—*The Inferior Oölite.*

Upon the Upper Lias the Inferior Oölite rests nearly comformably. In the S.E. of the county it comes within a mile or two of the borders at Wardley, west of Uppingham, and thence to Stoke Dry. Again, about one mile north of Market Overton, and near Thistleton, it comes almost to the edge of Leicestershire, but does not, we believe, fairly enter the county. Between this and the northern edge of Buckminster Park, the whole of the intervening country appears to be upheaved between the Hoton Fault on the N. and another parallel to it through the N. end of Wymondham: this latter we may call the Wymondham Fault. The effect of this upheaval is to throw back the boundary of the Oölite to the E. of the British Road, which, leaving the Ermine street at Greetham Mill in Rutlandshire, runs N.W., and for 10 miles forms the boundary between the counties of Leicester and Lincoln. The Oölite in this part comes as far as North Witham and Stainsby. Woolsthorpe, the birth-place of Newton, stands a little within the boundary. About a mile S. of Skillington we come upon the Hoton Fault, which, being a downthrow to the N., carries the outer edge of the Oölite as far east as Sproxton, whence the boundary runs by Saltby to Croxton Kyrial, and thence follows the crest of the hills overlooking the Vale of Belvoir, winding round with them to the E. in the direction of Grantham. About a quarter of a mile E. of Croxton, on the road to Melton, a downthrow fault brings in a small outlier of the Oölite: and still further to the S. and E., about Waltham-on-the-Wolds and Stonesby, is a much more considerable one. The base of the Oölite in this quarter is a brown sand much resembling the marlstone, and in places containing a large amount of iron. Upon this rests a white limestone, exhibiting the characteristic roe-like structure which has originated the term

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* "A few years ago," says the late Thomas Gisborne, of Yoxall, "we should have looked for the least improved district of agricultural England from the top of Robin-a-tip-toes" (a hill of Upper Lias, with Marlstone at its western base, near Tilton-on-the-Hill.) "No prospect could, in an agricultural point of view, be more melancholy. Large spongy pasture fields, so encumbered with vast ant-hillocks that nothing but an accomplished hunter could gallop among them with safety, bounded by rambling fences, &c."—Quart. Rev., No. 168.

Oölite. Like the Marlstone, it forms a light friable soil well suited for barley and turnips, and its Flora will be found very interesting to those whose experience has been confined to the Lias Clays and Red Marls which form the bulk of Leicestershire.

We have here a great break in the ascending series of geological deposits; and the formations which overlie the Inferior Oölite must be sought to the E. and S.E. of the borders of the county. The Great Oölite approaches within two miles of the extreme South Eastern point of Leicestershire. It there rests unconformably on the Upper Lias; and it is not impossible that an outlier of it may eventually be found within this county; but the parts of Leicestershire included in sheets 64 and 70 of the Ordnance Map have not yet been subjected to the searching investigation of the Government Geological Surveyors. When we consider that the Lias is a deep sea formation, and observe the hills of 600 or 700 feet in elevation which it forms about Billesdon, we can hardly doubt that it once extended to the edge of Charnwood, if it did not actually cover it. Circling round both N. and S. of Charnwood, it was perhaps once continuous with the fragments of the same formation on Needwood Forest, west of Burton-on-Trent. How far towards the borders of this county the more recent formations extended, it is impossible to say; it is certain that up to the chalk, they all once spread far to the N.W. of their present limits. But if any of them ever entered Leicestershire they were probably denuded during the Tertiary period. No strata of that age were deposited within the borders of the county except some of the Newer Pleiocene, the very uppermost.

VI.—NEWER PLEIOCENE TERTIARIES.

In the valley of the Soar and Wreke are extensive deposits of a loamy character, apparently consisting of Red Marl and Lias Clay, in variable proportions, with an admixture of smaller quantities of other materials. These loams are frequently worked for bricks; they attain in places nearly 100 feet in thickness. It is not always easy to distinguish them from undisturbed Red Marl; but they have generally less coherence, and little trace of stratification. Good sections of these beds may be seen at Broughton Astley Station, where a Liassic character predominates; near Brooksby and Rotherby, in the valley of the Wreke; and in Loughborough Park Lane; in these the Red Marl element prevails. In the latter place, grinders and tusks of *Elephas primigenius* have been found; some of which are preserved in the Museum at Leicester. These we believe to be the oldest beds of the Newer Pleiocene Period in the country.

Scattered over the county may be found deposits of drift gravel containing Lias Limestone pebbles and fossils (such as *Belemnites* and *Gryphæa incurva*),—flints and silicified *Echinoderms* from the chalk,—and the like. The characteristic parts of this gravel must have come to us from the E., and we therefore include all deposits of this nature under the name of Eastern Drift. A large quantity of this gravel may be seen at Charnock Hill, near Diseworth, and near Formark Park Farm, west of Tickenhall. The great fissure which is formed by the Coleorton Fault is seen in the railway cutting to be filled with matters of this nature, and the dissolved chalk, oölite, and lias pebbles have cemented some parts of the gravel into a conglomerate. Vast accumulations of this gravel cap the hill at Cold Overton, obscure the course of the Marlstone at Owston, and cover a large area at Misterton, near Lutterworth, and elsewhere. As we find this drift often capping the highest ground in the neighbourhood, as on Hill Top, Ashby-de-la-Zouch, (470 feet above the sea), and on Smisby Common (600 feet), on the W. of the county; as well as at Cold Overton, Laughton, Gumley,* on the E., it would seem to have been once generally distributed, and since removed by denudation, and the excavation of the existing valleys.

At a later period drift appears to have been brought by ice from the N. During a portion of this time, Charnwood, already stripped of its covering of Red Marl, seems again to have formed a shoal or island in the glacial sea, obstructing the southern passage of the ice. Along the northern shore of this island the ice grounded and thawed, depositing immense quantities of detritus, chiefly blocks of Millstone Grit and Carboniferous Limestone, with numerous fragments of coal. These accumulations in the neighbourhood of Sheepshed sometimes attain a thickness of 50 feet, and the coal contained in them has created a popular delusion that seams of that mineral exist below. In the period immediately preceding or following that in which the grounded ice was depositing a moraine at the northern base of Charnwood, the whole of the Forest country was submerged, and the ice drift from the N. passed over both it and the Wold Hills in the N.E. of the county. The ice grounding on the ridges of the hills, tore up and carried away to the southwards immense quantities of their materials. The eastern parts of the county S. of the ridge of the Wold Hills are widely covered with drifted clay, imbedding numerous blocks of Oölitic Limestone. Further to the W. the same effect has been produced in the case of the Charnwood rocks; the detritus of these has been carried away S. and S.W. towards Hinckley and Atherstone, and large blocks of porphyry and slate are found scattered for 20 miles in that direction. This "Forest Drift" is certainly of later age than the "Eastern Drift" above described; for when the two are found together the Forest Drift is always uppermost.

Since the epoch of the Forest Drift little geological change has taken place in this county. During the final rise of our island above the waters at the conclusion of the Glacial Period, a good deal of superficial denudation took place. The existing valleys were at that time for the most part scooped out through all the drifts above described, and some of the older formations below them. Much of the matter then removed, was brought down to the valley of the Trent, then still an arm of the sea. And the drift pebbles (there mingled with large quantities of quartz gravel derived from the conglomerates,) have there formed extensive beds, in some places 30 feet in thickness.

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* Memoirs of the Geological Survey.—Description of Quarter Sheet 63 S.E. By Mr. H. H. Howell.

VII.—Recent Deposits.

The local deposits of peat and alluvium, which have been made since the last emergence of the land, are no where very remarkable for magnitude in Leicestershire, though they are well-worthy of the attention of local students of geology.* For they cannot fail to learn from these comparatively minute matters, something that will better enable them to understand the gigantic results of bygone changes.

W. H. C.

APPENDIX.

No. 1.—Section of Bagworth Colliery.

		Ft.	In.			Ft.	In.
	Marls and Skerries	141	0		**Coal**	1	6
	Stone	3	0		**Fire Clay**	4	6
	Marl	21	0		**Bind**	8	0
	Stone	2	0	40	**Black Batt**	0	5
	Marl	36	0		**Coal**	1	6
	Stone	20	6		**Stone**	6	0
	Marl	14	0		**Bind**	8	0
	Stone	3	6		**Fire Clay**	1	3
	Marl	71	0		**Coal**	4	1
10	**Stone**	4	0		**Fire Clay**	3	0
	Bind	9	0		**Clunch**	3	0
	Coal	1	4		**Bind and Ironstone**	1	6
	Fire Clay	4	0		**White Stone**	1	0
	Bind and Ironstone	12	0	50	**Blue Bind**	6	4
	Grey Stone	10	1		**White Stone**	1	6
	Blue Bind	21	0		**Blue Bind; ironstone**	12	8
	Coal	4	0		**White Stone**	0	9
	Batt	0	9		**Bind**	6	9
	Coal	1	7		**Coal**	2	10
20	**Blue Bind**	43	6		**Clunch and Ironstone**	6	2
	Shale	0	4		**Bind and Ironstone**	1	6
	Coal	7	0		**Stony Bind**	8	4
	Hard Clunch	4	6		**Stone**	20	3
	Soft Bind	25	6	60	**Rocky Binds; ironstone**	2	3
	Coal	5	0		**White Stone**	1	4
	Batt	0	6		**Coal and Cannel**	2	8
	Coal	4	6		**Clunch**	0	5½
	Clunch	5	0		**Coal**	0	6
	Bind	18	0		**Batt**	0	1
30	**Clunch**	6	0		**Clunch**	3	9
	Mussel Bed	1	0		**Stony Bind**	12	9
	Hard Stone	2	0		**Dark Bind**	3	0
	Stony Bind	6	0		**Dark Shale**	19	9
	Bind	6	0	70	**Coal**	2	3½
	Shale	1	0		**Clunch**	0	8½
	Bind and Ironstone	1	0		**Coal**	2	2½

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* We have lately been informed that human remains have been found near Bottesford, in company with bones of extinct animals. This is a circumstance which deserves to be carefully enquired into.

		Ft.	In.
	Clunch	7	6
	Blue Bind	9	0
	Stone Bind	16	6
	Stone	3	6
	Bind	1	6
	Stone	1	0
	Bind	5	0
80	Coal	0	10
	Fire Clay	0	3½
	Coal. Upper Main	5	0
	Fire Clay	6	0
	Bind; ironstone balls	3	0
	Stone Bind	10	0
	Fire Clay; ironstone	2	0
	Stone Bind	4	6
	Bind	21	9
	Fire Clay	0	6
90	Coal	2	0
	Fire Clay	9	5
	Bind	5	0
	Stone	5	0
	Stone Bind	24	0
	Bind	12	0
	Batt	1	6
	Coal	4	6
	Fire Clay	3	0
	Stone	15	6
100	Shale	4	0
	Fire Clay	0	3
	Coal	3	3
	Fire Clay	8	6
	Coal	3	1
	Clunch	1	0
	Stone Bind	16	8
	Stone	9	0
	Stone Bind	3	0
	Stone	1	8
110	Bind	19	6
	Shale	1	0
	Coal	3	7
	Fire Clay	9	0
	Coal. Lower Main	8	3

No. 2.—Section of Calcutta Pit, Swannington.

		Ft.	In.
	Soil	1	3
	Soft Yellow Clay	5	0
	Blue Clay	2	6
	Blue Bind; pebbles and ironstone	8	9
	Blk. Shale & Brassil Coal	1	0
	Strong Black Shale	1	0
	Black Rammel	1	0
	Blue Bind	1	4
	White Stone	0	6
10	Blue Bind	7	10
	Coal	1	0
	Soft Blue Bind	1	0
	Light Fire Clay	8	3
	Ironstone	0	1½
	Blue Bind	3	7½
	Ironstone	0	2½
	Blue Bind; ironstn. balls	9	6
	Dark blue Bind	6	1½
	Coal	0	6
20	Rotten Black Batt	0	3
	Fire Clay	3	9
	Ironstone Ball	1	3
	Blue Bind.	1	3
	Dark Soft Bind	0	6
	Blue Bind ironstn. beds	10	6
	Black Batt.	0	6
	Coal. Stone Smut Rider	3	9
	Dark tough Bind	0	6
	Strong Stony Bind	4	11
30	Ironstone	0	7
	Strong Bind; ironstn. beds	10	10
	Strong Dark Bind	5	4
	Black Shale	0	8
	Strong Blue Bind	5	4
	Ironstone	0	4
	Bind	3	3
	Coal. Stone Smut	6	0
	Black Clunch or Stone	1	6
	Soft Black Bind	1	0
40	Black Shale	2	0
	Fire Clay or Clunch	2	9
	Strong Bind	9	10
	Bind	1	11
	Coal. Swannington	4	6
	Strong Clunch	7	6
	Grey Stone	7	0
	Strong Bind	10	11
	Black Batt	0	8
	Bronze Bed	0	1½
50	Coal	0	4
	Black Batt	0	5½
	Clunch or Fire Clay	1	0
	Strong Bind	3	6
	Hard White Stone	1	6
	Strong Stony Bind	5	9
	Tough Sloam	0	1
	Grey Stone	4	0
	Black Shale	0	2
	Coal. Soft or Three Qr.	2	3
60	Sloam	0	4
	Fire Clay	2	2
	Strong Clunch	3	6
	Soft Bind	0	8
	Strong Bind	4	9
	Black Shale	1	0
	Strong Bind; ironstone	2	7
	White Stone	6	0
	Strong Bind	17	4
	Black Shale	1	0
70	Coal. Slate Coal Rider	1	3
	Light Fire Clay	0	8
	Strong Clunch	13	0
	Strong Bind; ironstone	2	6

			Ft.	In.
	Black Shale		0	4
	Coal	Slate Coal	4	0
	Brown Stone		0	1
	Coal		1	2
	Fire Clay		8	0
	Strong Clunch		6	8
80	Blue Bind		14	0
	Ironstone		0	5
	Blue Bind; shells		7	10
	Blue Bind		10	0
	Black Shale		4	9
	Ironstone		0	4
	Black Shale		0	7
	Sloam		0	4
	Dark Bind		0	4
	Ironstone		0	2½
90	Strong Blue Bind		9	0
	Ironstone		0	8
	Light blue Bind		4	0
	Coal	Yard	2	10
	Sloam		0	9
	Coal		0	9
	Fire Clay		3	3
	Dk. Clunch; ironstone balls		6	6
	Strong Stony Bind		7	9
	Grey Cank		8	3
100	Grey Rock		2	9
	Strong Blue Bind		1	6
	Grey Rock		0	9
	Blue Bind		1	0
	Grey Rock		4	8
	Blue Bind		5	2½
	Black Batt		0	8
	Coal. Rattlejack		2	0
	Sloam		0	2
	Coal. Shale and brassil		1	2
110	Strong Bind		7	5
	Hard Grey Rock		1	8
	Stony Bind		4	0
	White Stone		0	6
	Strong Stony Bind		7	0
	Blue Bind		7	6
	Dk. blue Bind; ironstone		2	4
	Dark blue Bind		2	6
	Dark blue Bind and Cank		4	8
	Dark blue Bind		8	6
120	Rattlejack (Coal 0 1½)		2	2
	Reddish Bind		5	2
	Tender Bind		1	2
	Rattlejack		0	6
	Black Stone		0	2
	Coal, Stinking		4	3
	Sloam		0	2
	Fire Clay		0	10
	Clunch		6	0
	Strong Bind		7	7
130	Stony Bind		8	7
	Grey Rock		34	0
	Tender Bind		5	0
	Coal. Main		7	6

No. 3.—*Section of the Church Pit, Gresley Common, in the Moira Coal Field.*

			Ft.	In.
	Pit Bank		3	8
	Soil		0	9
	Yellow Clay		4	0
	Dark blue Bind		11	0
	Coal		0	10
	Grey Clunch		6	11
	Fire Clay		4	0
	Coal		0	4
	Grey Pot Clay	The Sagger and Bottle Clays	4	0
10	Grey Clunch		7	7½
	Grey Clunch		5	6
	Black Batt		1	0
	Coal		0	2
	Black Batt		1	0
	Grey Clunch		4	7
	Black Batt		0	5½
	Coal		1	0
	Grey Clunch		0	7
	Grey and black Pot Clay		8	0
20	Coal		2	2
	Light Grey Pot Clay		4	0
	Black Pot Clay		0	8
	Coal (The Eln Coal)		3	11
	Black Batt		1	0
	White Clunch		1	1
	Coal		1	6
	Grey Clunch		1	6
	Coal		3	0
	Black and grey Pot Clay		1	7
	Coal		0	10
30	Black Clunch		3	6
	Black Batt and Bind		4	1
	Coal		0	10
	Black Bind		3	2
	Black Ironstone		0	4
	Dark Blue Bind		3	0
	Brown Ironstone		0	4
	Dark Blue Bind		6	8
	Coal (123 M.)		3	2
	Light grey Pot Clay		4	1
40	Dark grey Bind		7	6
	Black Batt	(126)	1	3
	Coal		1	0
	Grey Clunch and Bind		3	0
	Light grey Clunch		2	6
	Brown Cank		0	6
	Grey stone Bind		1	6
	Light brown Cank		0	9
	Grey stone Bind		6	9
	Light blue Bind		2	11
50	Tender Bind		2	8
	Grey Clunchy Bind		2	10
	Coal (142, 143)		0	6
	Grey stony Clunch		2	6

		Ft.	In.
	Dark blue bind	3	8
	Strong blue Bind	5	0
	Black Batt	0	8
	Coal (149)	1	8
	Grey clunchy Bind	7	3
	Strong Bind	2	9
60	Stony Bind	1	3
	Dark blue Bind	3	6
	Grey Rock	5	4
	Dark blue stony Bind	7	5
	Light blue Bind	4	6
	Dark blue Bind	4	10
	Blue Bind	8	9
	Black Batt (166)	1	6
	Dark blueBind&Ironstone	5	0
	Black Batt (171)	2	3
70	Dark blue Sloam	0	5
	Coal (172)	0	9
	Dark grey Clunch	1	9
	Grey clunchy Bind	2	0
	Dark blue Bind	11	2
	Black Batt (177 178)	12	2
	Dark blue Bind	19	0
	Black Batt (195)	2	3
	Dark blue Bind	1	9
	Brown Ironstone	0	3
80	Light blue Bind	3	6¼
	Drab Ironstone	0	2½
	Light blue Bind	7	6
	Brown Ironstone	0	2
	Light blue Bind	1	9
	Light brown Ironstone	0	2
	Blue Bind	4	6½
	Light brown Ironstone	0	3
	Blue Bind	4	0
	Dark blue Bind	2	0
90	Black Batt	1	1
	Coal (DickyGobbler,222)	3	8
	Dark blue Sloam	0	6
	Grey clunchy Bind	8	4
	Blue Bind	2	0
	Dark blue shaly Bind	6	5
	Brown Ironstone	0	2
	Dark blue Bind	3	6
	Black Batt.	2	2
	Brown Ironstone	0	4
100	Light blue Bind	7	3
	Light brown Ironstone	0	3
	Blue Bind	5	10
	Light brown Ironstone	0	1½
	Black Batt	3	1½
	Black Ironstone	0	1¼
	Dark blue Bind	1	11½
	Coal (250)	2	2
	Black Sloam	0	6
	Light grey Sloam	0	6
110	Clunchy blue Bind	6	6
	Blue Bind	6	10
	Dark blue Bind	6	6
	Brown Ironstone	0	1½
	Black Bind	4	0
	Dark brown Ironstone	0	2
	Dark blue Bind	1	11½
	Black Bind	0	7
	Stone, with Shells	11	0
	Black Batt	7	6
120	Grey Sloam	0	9
	Grey stony Bind	3	3
	Dark blue Bind	4	0
	Light grey Stone	5	6
	Dark blue Bind	1	6
	Light grey Stone	0	6
	Dark blue Bind	3	0
	Brown Ironstone	0	2
	Dark blue Bind	3	4
	Black Batt	3	0
130	Black Bind	3	3
	Brown Ironstone	0	2
	Blue Bind	6	8
	Brown Ironstone	0	3
	Blue Bind	0	6
	Brown Ironstone	0	2
	Black Batt	2	6
	Coal (Jack Dennis, 271)	4	3
	Dark grey Sloam	1	0
	Dark grey Clunch	4	0
140	Light grey Stone	12	7½
	Dark grey Bind	10	0
	Dark blue Bind	2	0
	Black Batt	3	10
	Dark grey Clunch	3	2
	Clunchy blue Bind	9	0
	Blue Bind	3	2
	Coal (286)	2	8
	Soft black Sloam	0	6
	Dark blue clunchy Bind	9	2
150	Blue Bind	3	0
	Grey Stone	1	6
	Blue stony Bind	1	0
	Grey Stone	2	6
	Blue Bind	3	0
	Brown Ironstone	0	1½
	Blue Bind	3	10
	Black Batt	3	0
	Black Sloam	1	0
	Black Batt	1	0
160	Dark blue Bind	1	8
	Brown Ironstone	0	2
	Blue Bind	4	8
	Brown Ironstone	0	3
	Blue Bind	3	0
	Brown Ironstone	0	2
	Black Batt } 303 {	2	10
	Coal	1	5
	Dark grey Sloam	0	10
	Dark grey Clunch	1	0
170	Light grey clunchy Stone	3	0
	Stony blue Bind	2	0

		Ft.	In.
	Brown Cank	0	9
	Stony blue Bind	5	3
	Black & grey stony Bind	1	9½
	Strong blue Bind	4	6
	Yellow Ironstone	0	2
	Blue Bind	2	2
	Yellow Ironstone	0	2
	Blue Bind	1	6
180	Brown Ironstone	0	1½
	Blue Bind	8	4½
	Dark blue Bind	1	8½
	Black Batt	4	0
	COAL	0	5
	Black Batt	1	1
	Black Clunch	6	6
	Blue Bind; Ironstone	0	6
	Black Batt	0	6
	COAL	0	5
	Black Batt	2	0
190	Blue and grey Clunch	2	6
	Black Batt	1	0
	Light grey Stone	4	3
	Strong blue Bind	17	0
	Brown Ironstone	0	3
	Blue Bind	1	9
	Black Batt	2	6
	Dark blue Bind	0	6
	Brown Ironstone	0	4
	Blue Bind and Ironstone	6	8
200	Black Batt.	0	2
	Brown Ironstone	0	2
	Dark blue Bind.	0	5
	Blue Bind	6	0
	Light Brown Ironstone	0	3
	Blue Bind	2	0
	Blue Bind & Black Batt	2	0
	Dark blue Bind	8	8½
	Strong blue Bind.	4	8
	Light blue stony Bind	4	0
210	Grey stony Bind	2	6
	Blue Bind	0	9
	Light brown Cank	0	9
	Light grey Stone	27	1
	Blue Bind	4	1
	COAL (Five-foot 335)	5	0
	Light grey Sloam	2	0
	Black Batt	8	7
	Light blue Bind	6	0
	Brown Ironstone	0	1
220	Light blue Bind	4	6
	Brown Ironstone	0	2
	Dark blue Bind	3	0
	Dark Sloam	0	8
	Strong blue Bind	2	1½
	Blue Bind and Ironstone	25	5
	Ironstone	0	1½
	Strong Bind	0	7
	COAL (Cannel 354)	2	7
	Clunch	1	2½
230	COAL	0	6
	Tender Clunch	0	10½
	Stony Clunch; Ironstone	8	4
	Grey Stone	4	10
	Bind	5	1
	Grey Stone	1	9
	Bind and Ironstone	2	8
	Grey Stone	7	6
	Strong Bind & Ironstone	2	8
	Grey Stone	0	10
240	Cank	4	0
	Grey Stone	1	2
	Brown Stone	0	2
	Grey Stone	4	0
	Strong Bind	1	11
	Bind	0	5
	Ironstone	0	8
	Bind	2	9
	Ironstone	0	2
	Bind and Ironstone	4	6
250	Ironstone	0	2
	Bind	2	4
	Ironstone	0	2½
	Bind	1	3
	Ironstone	0	1½
	Bind	4	5
	Ironstone	0	3½
	Bind; Ironstone Balls	2	3
	Ironstone	0	6
	Bind	2	4
260	Ironstone	0	6
	Bind	0	8
	Ironstone	0	2
	Bind; Ironstone	2	9
	Ironstone	0	9
	Bind; Ironstone Sheds	43	7½
	Bind; Ironstone Balls	7	8
	COAL (Rider 392)	3	1
	Black Batt	1	1
	COAL	0	6½
270	Tow	1	11½
	COAL (Over) } 396	4	4
	Clod	0	10½
	COAL (Nether).	6	10

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